ESDIS

# EOS Ground System (EGS)

## Chemistry Cooperative Agreement Kickoff/Workshop

ESDIS

# Agenda


| | |
|---|---|
| • Introduction/EGS Overview | Dan DeVito |
| • EGS Support for Chem-1 | Bob Nelson |
| • Mission Systems | Mike Rackley |
| • Science Systems | Dan DeVito |

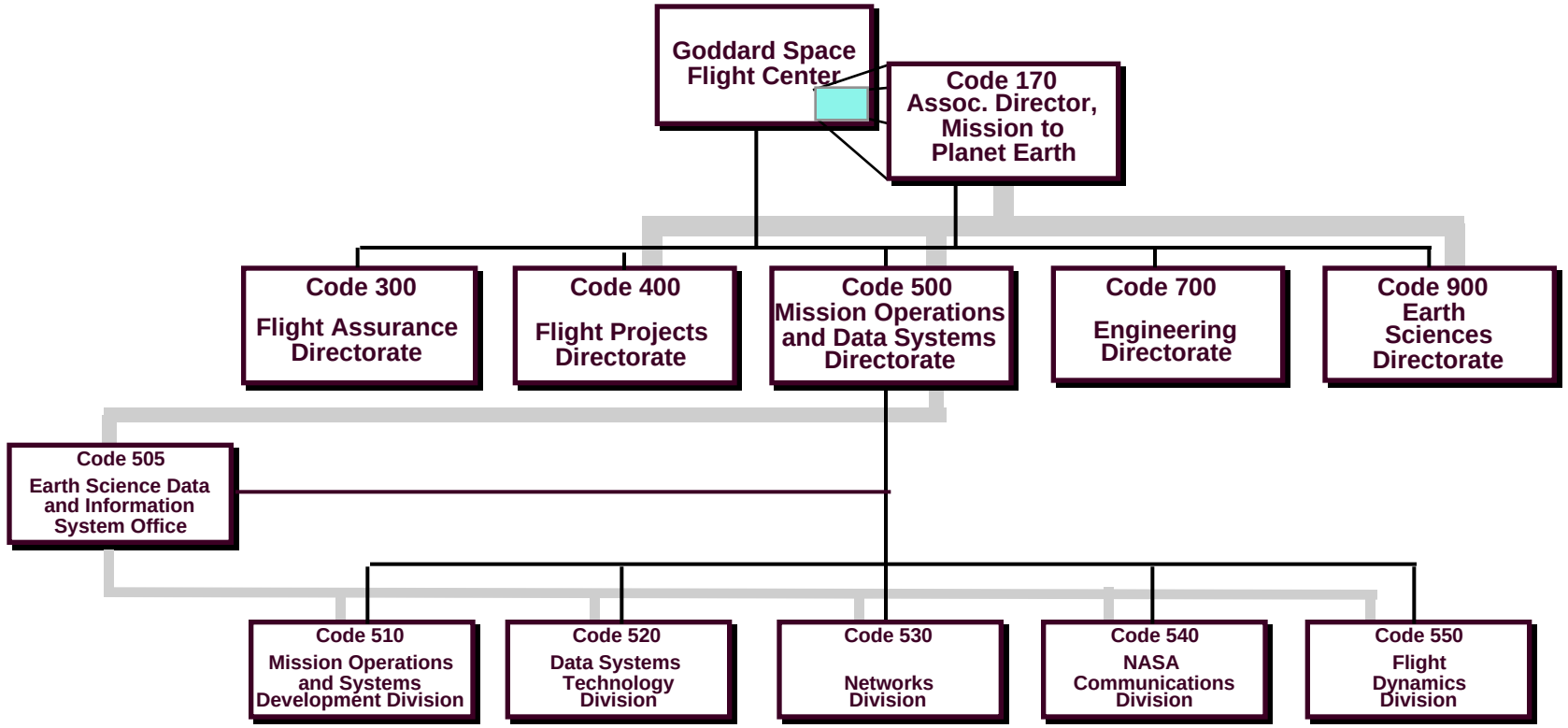
ESDIS


# Introduction /EGS Overview

**Dan DeVito**
**Manager, Systems Engineering**
**ESDIS Project, NASA / GSFC**

ESDIS

# MO&DSD at GSFC



ESDIS

# MO&DSD Role


- Mission Systems
  - Mission planning and scheduling
  - Command management
  - Health and safety monitoring
  - Real-time command and control
  - Network configuration and performance monitoring
  - Orbit and attitude computations
  - Data capture and preprocessing
- Science Systems
  - Science processing
  - User services
  - Active archive development and maintenance
  - Long term archive maintenance
  - Data product distribution

ESDIS

# Mission Systems Technology


- MO&DSD exploring uses of new technologies/approaches to mission operations, both inside and outside of EOSDIS
- Automated (lights-out) mission operations
  - Expert systems (GenSAA/RTWorks)
    - TPOCC missions, AM-1
  - State modeling (Altair)
    - AM-1, Landsat-7, UARS Upgrade
  - Automated procedures (Genie/GenSAA/ground scripts)
    - AM-1, Sampex, EUVE/APOCC
  - Remote access via WWW/Java
    - AM-1, ST Vision 2000
  - Low cost, high rate receivers
    - Code 520 chips/cards

ESDIS

# Mission Systems Technology


- Orbit control
  - Autonomous formation flying
    - Tight tolerances (~1 minute), onboard control
    - NMP EO-1 & L-7 mission
  - Autonomous orbit maintenance
    - Onboard software performs orbit maneuvers
    - Navy's UFO-1 with SAIL
  - Spacecraft constellation maintenance
    - Higher tolerances (>1 minute), ground control
    - AM-1 and Landsat-7

ESDIS

# Mission Systems Technology


- Space/ground communications
  - Inexpensive COTS ground terminals
    - Small (3 meter) antenae
  - COTS ground network for spacecraft support
    - Vendor-provided service
    - Highly automated “Lights-out” operation
    - EOSDIS commercial ground stations
    - TRACE and POEMS experiment

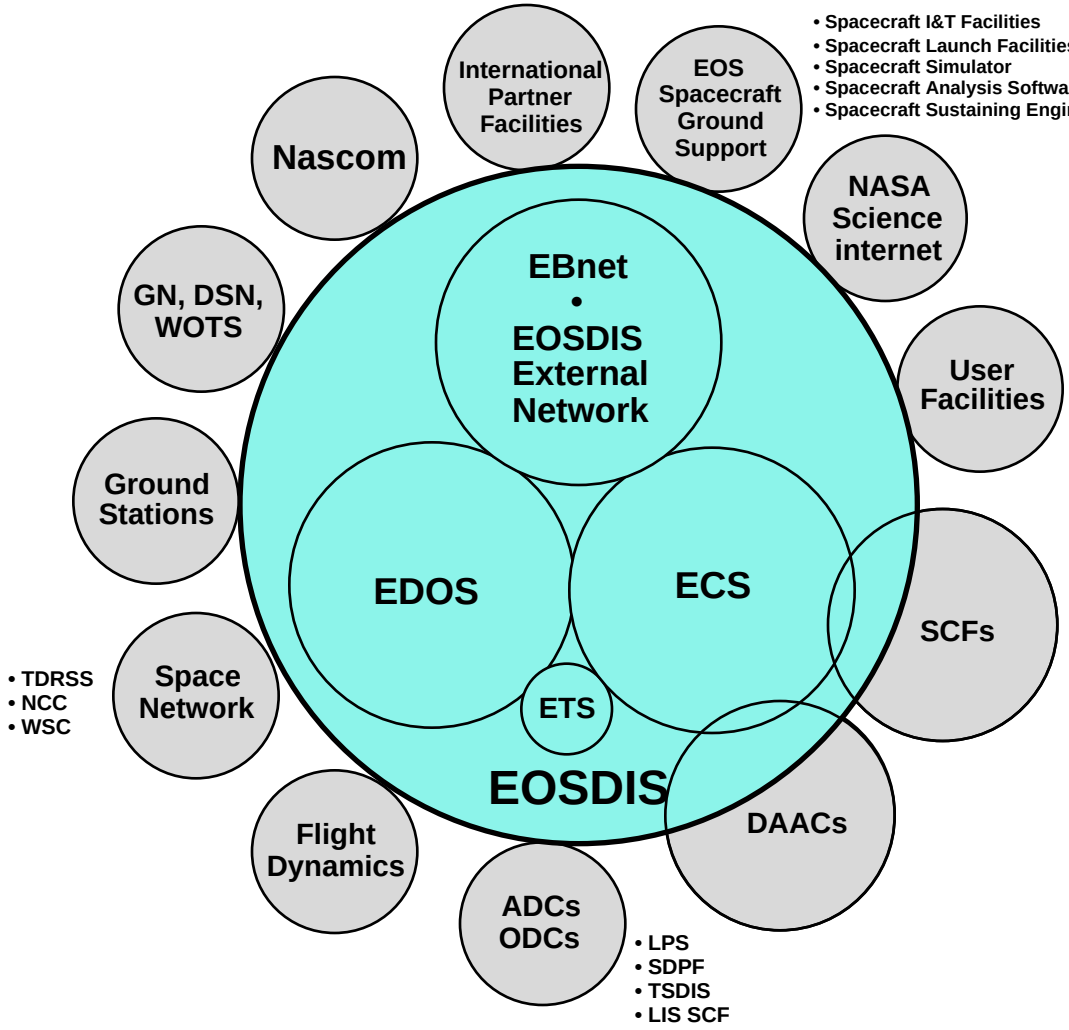
ESDIS

# Science Systems Technology


- Provide leadership in all life cycle phases of state-of-the-art science systems
  - Distributed, interdependent science planning and processing
    - Automated archive
    - Science Processing
    - Metadata generation
    - Toolkits for porting science software
  - Distributed systems management
    - Performance monitoring, security, trend analysis, etc.
  - Interoperability with inter-agency, international partner data systems
  - Planned prototyping for risk abatement and functional/ performance enhancement (e.g. data mining, parallel processing)
    - http://spsosun.gsfc.nasa.gov/EOSDIS_evol.html

ESDIS

# EGS Overview



ESDIS

# EOSDIS Elements


- EOSDIS Core System (ECS): provides EOSDIS core capabilities
  - Flight Operations Segment (FOS)
  - Science Data Processing Segment (SDPS)
  - Communications and Systems Management Segment (CSMS)
- EOS Data and Operations System (EDOS): provides EOS spacecraft data handling services
- EOSDIS Backbone Network (EBnet) and an EOSDIS external network: provides EOS mission and data communications services
- EOS Test System (ETS): provides EOSDIS test and simulation capabilities
- EOSDIS Ground Stations: performs Space to ground communications services beginning about year 2000
- Distributed Active Archive Centers (DAACs): operational data centers, including operations of Version 0
- Science Computing Facilities (SCFs): develops science software and perform science data quality assessment
- Science software: investigator-developed software and algorithms

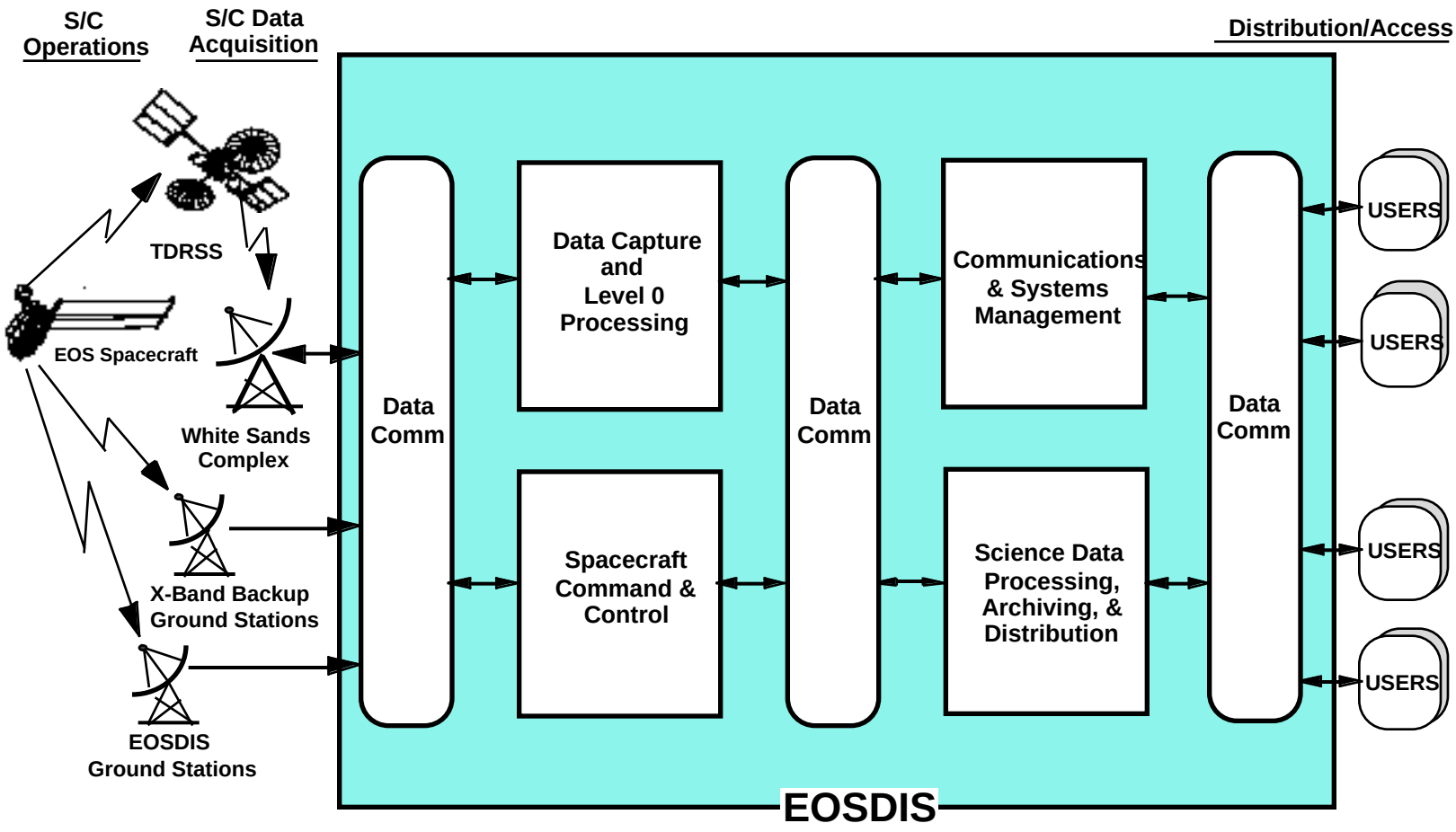
ESDIS

# Institutional Elements


- Flight Dynamics
  - Orbit, attitude, and computational services
- Nascom
  - Communications services between White Sands Complex (WSC) and EGS elements
- Space Network
  - TDRSS support and tracking services
- Ground Network (GN), Deep Space Network (DSN), Wallops Orbital Tracking Station (WOTS)
  - Backup low-rate communications services
- X-Band backup ground stations
  - Backup science data communications services for AM-1

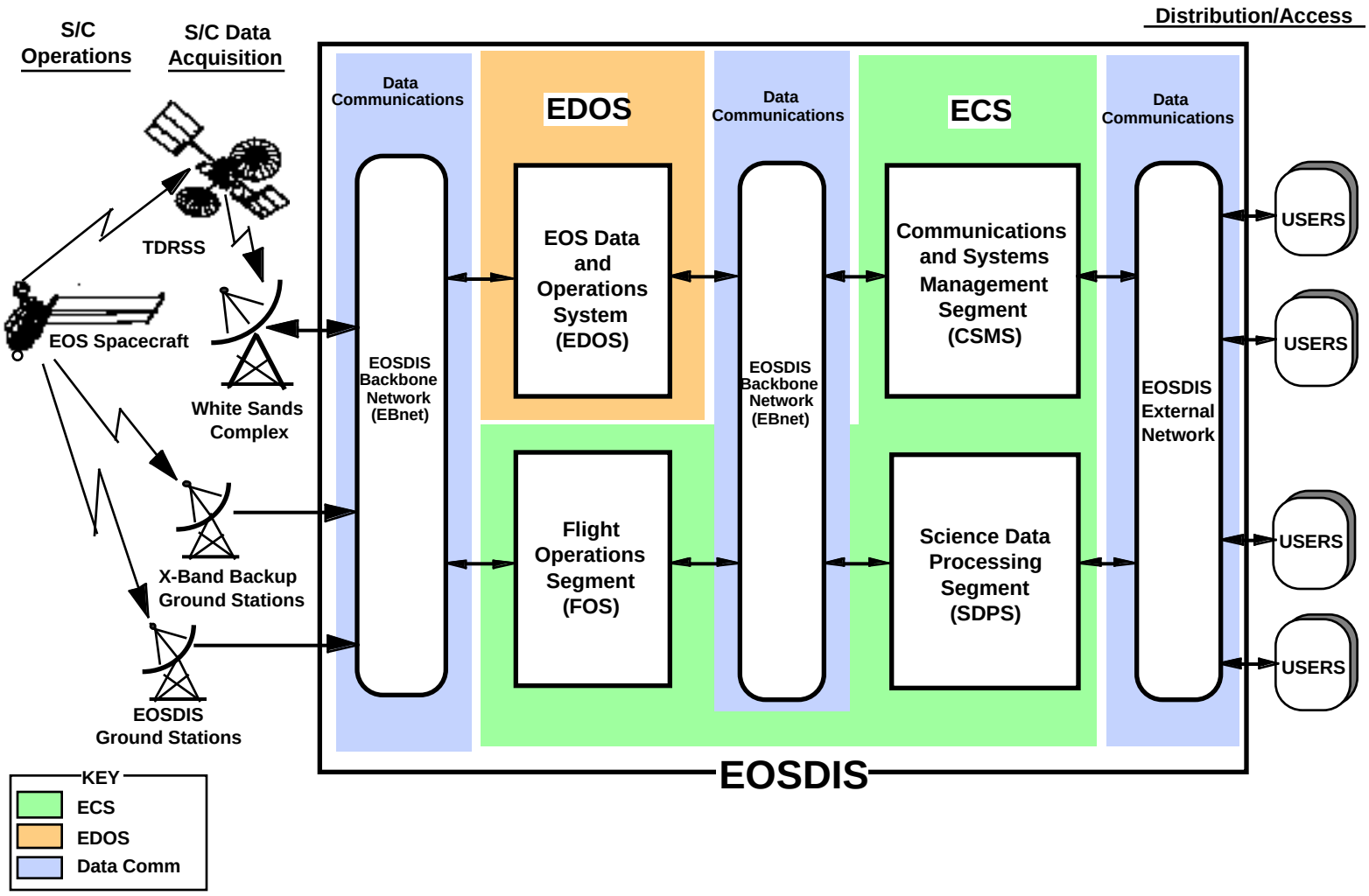
ESDIS

# EOSDIS Functional Architecture



ESDIS

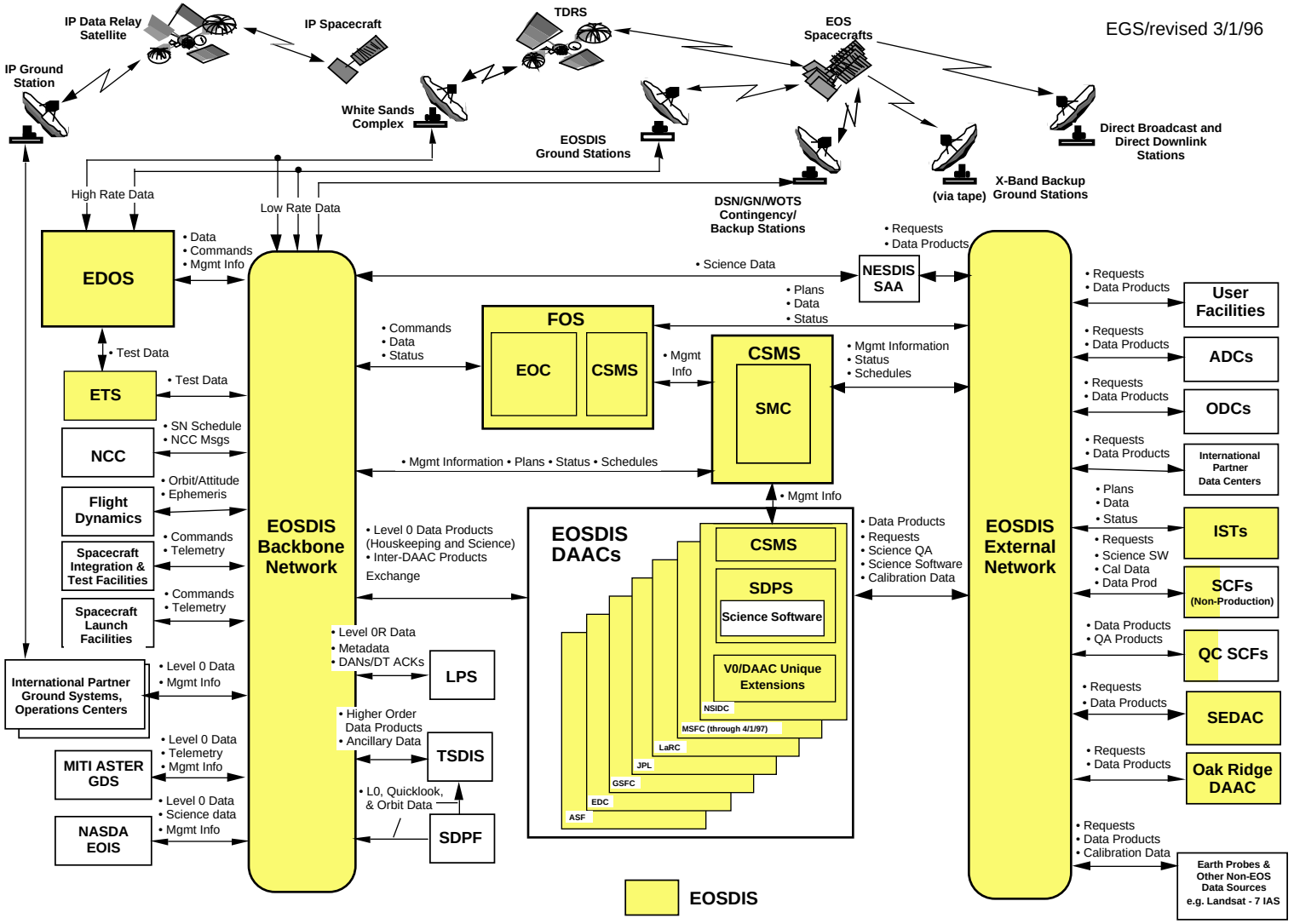
# EOSDIS Reference Architecture



ESDIS

# EOSDIS Physical Architecture

EOS



ESDIS

# Where To Get More Info


- EGS level documentation:
  - EGS System and Operations Concept
  - Architecture Description Document
  - http://esdis.gsfc.nasa.gov/SYSENG
- ECS authored interface documentation
  - http://edhs1.gsfc.nasa.gov
- All baselined requirements and interface documentation
  - ESDIS Library, Building 32, Room E148. Contact Daphne Rodriguez, (301) 614-5118.

ESDIS


# EGS Support for Chem-1

**Bob Nelson**

**Manager, Mission Support**

**ESDIS Project, NASA / GSFC**

ESDIS

# Mission Specific Requirements


- ESDIS shall provide flight operations support, and generate, archive and distribute standard products from the HIRDLS, ODUS, MLS and TES instruments onboard the EOS-Chemistry series of spacecraft
- ESDIS shall provide forward and return link services, capture, Level Zero Process, and distribute data from the HIRDLS, ODUS, MLS and TES instruments on-board the EOS-Chemistry series of spacecraft
- ESDIS shall interface with International Partner, Japan, to coordinate payload planning and integration, mission management, and payload command and control as well as processing and the exchange of data and information for ODUS
- Japan will provide planning and scheduling of ODUS

ESDIS

# Mission Specific Requirements


- Ground system shall be capable of supporting spacecraft mission operations 24 hours per day, 7 days per week
- Expedited delivery of 2% of Level 0 instrument data
- End-to-end system shall be capable of performing system testing without the interruption of operational support
- Ground system shall provide sustaining engineering capability for the life of the EOS program
- 100% data recovery from primary spacecraft and 50% from secondary spacecraft during periods of overlapping missing (e.g. CHEM-1/CHEM-2)
- Data delivery to NOAA within 3 hours of observation

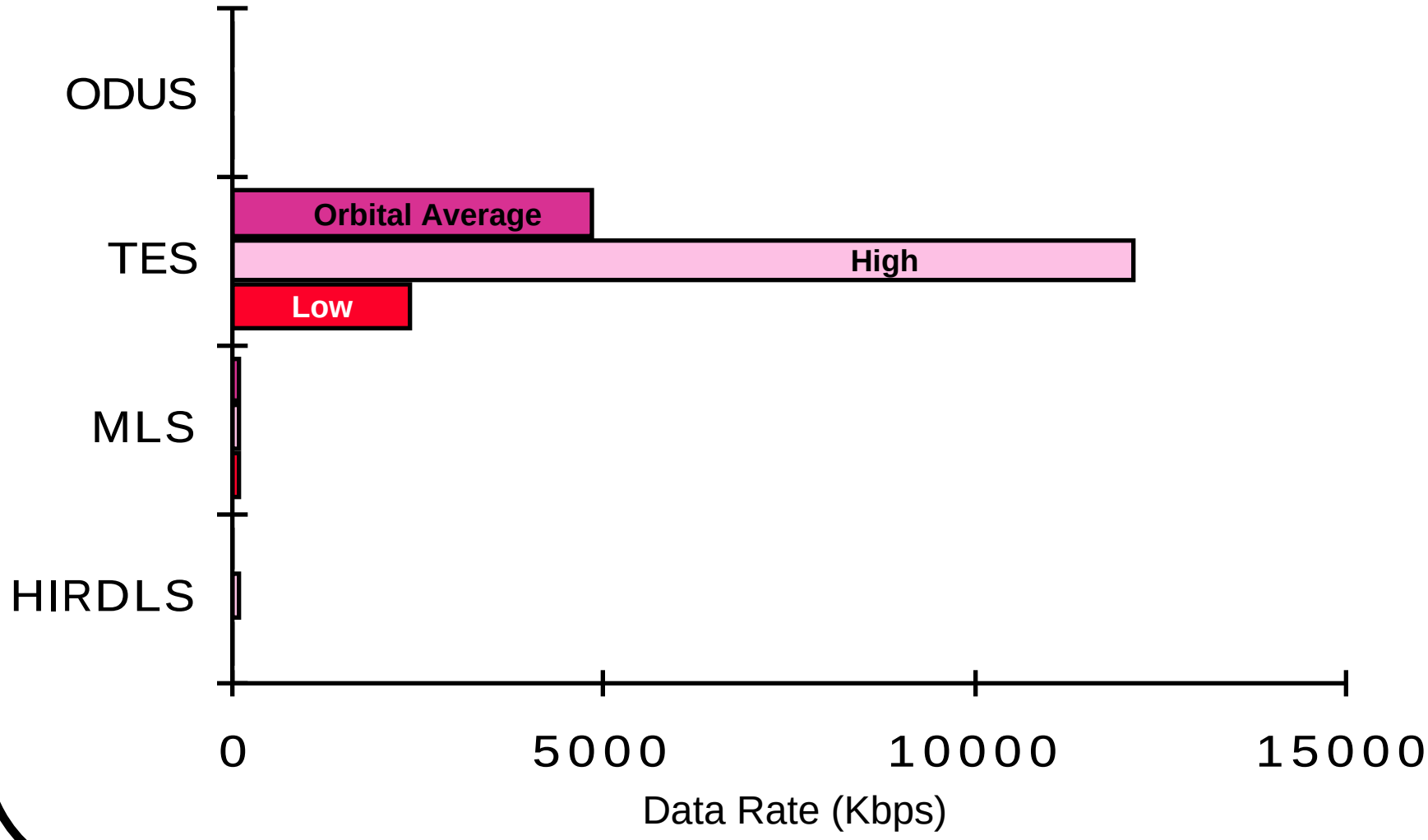
ESDIS

# Communications Link Requirements


- CCSDS grade 2 standards
- Undetected bit error rate of delivered data <1x10E9 bits
- End-to-end system shall support daily uplink of a 24-hour command load (<20 minutes)
- Receipt and pre-processing of data for backup operations in the event of primary space/ground link failure
- Spacecraft to support X-band downlink of selected science and housekeeping data
- Use TDRSS for health and safety telemetry and command
- Multiple Chemistry spacecraft support assumptions:
  - 15 minute separation between spacecraft
  - Downlink rate sufficient to dump solid state recorder in half of contact time
    - 150 Mbps for spacecraft with TES instrument
    - 4-5 Mbps for low data volume instruments

ESDIS

# Requirements: Data Rates



ESDIS

# Data Products

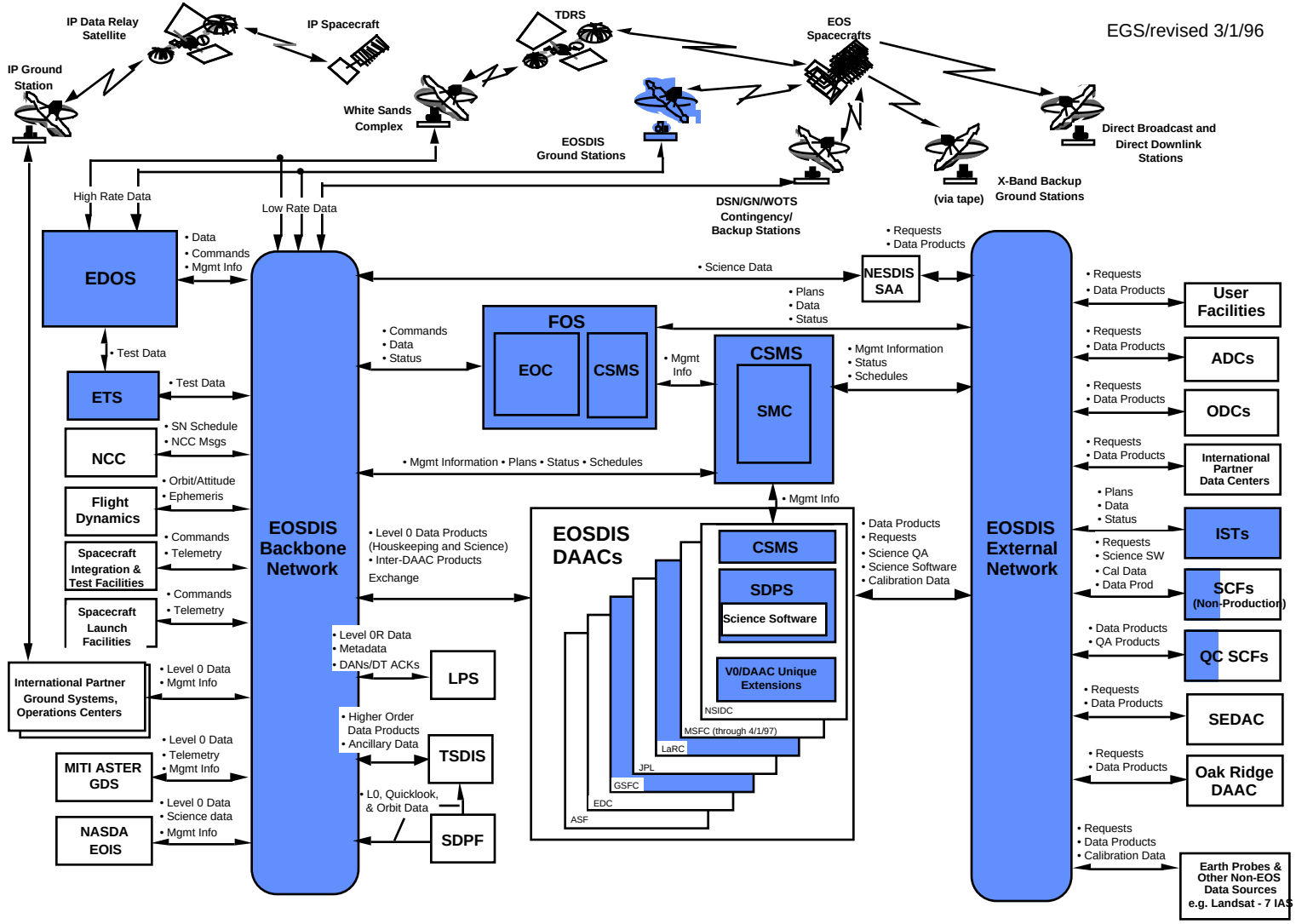
| DAAC | HIRDLS GSFC | MLS GSFC | TES LaRC | ODUS TBD |
|---|---|---|---|---|
| # of Products | 29 | 18 | 22 | |
| Level 1-A | | 1 | | |
| Level 1-B | 1 | 1 | 2 | |
| Level 2 | 14 | 1 | 11 | |
| Level 3 | 14 | 15 | 8 | |
| Level 4 | | | 1 | |

- Reference: EOS Output Data Products, Processes, and Input Requirements, ESDIS Project Science Office, GSFC, May 1996

ESDIS

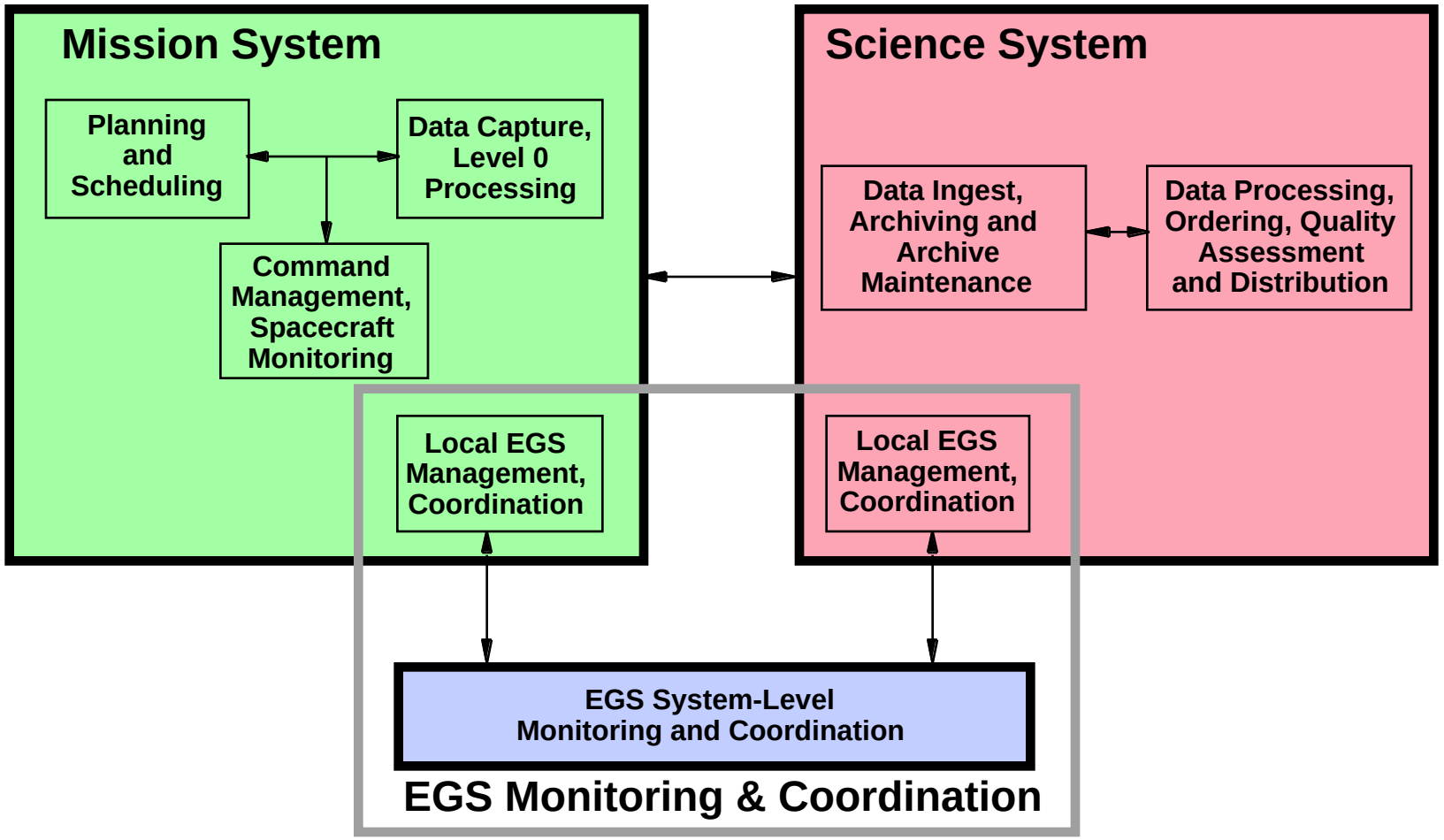
# EGS Elements Supporting Chem-1

EOS



ESDIS

# EGS Operations Concept



ESDIS


# Mission Systems

**Mike Rackley**

**Manager, FOS**

**ESDIS Project NASA / GSFC**

ESDIS

# EGS Operations Scenarios


- **Mission operations**
  - **Planning and scheduling**
  - **Command management and spacecraft monitoring**
  - **Data capture and Level 0 processing**
- **Science data operations**
  - **Data ingest, archiving, and archive maintenance**
  - **Data processing, ordering, quality assessment, and distribution**

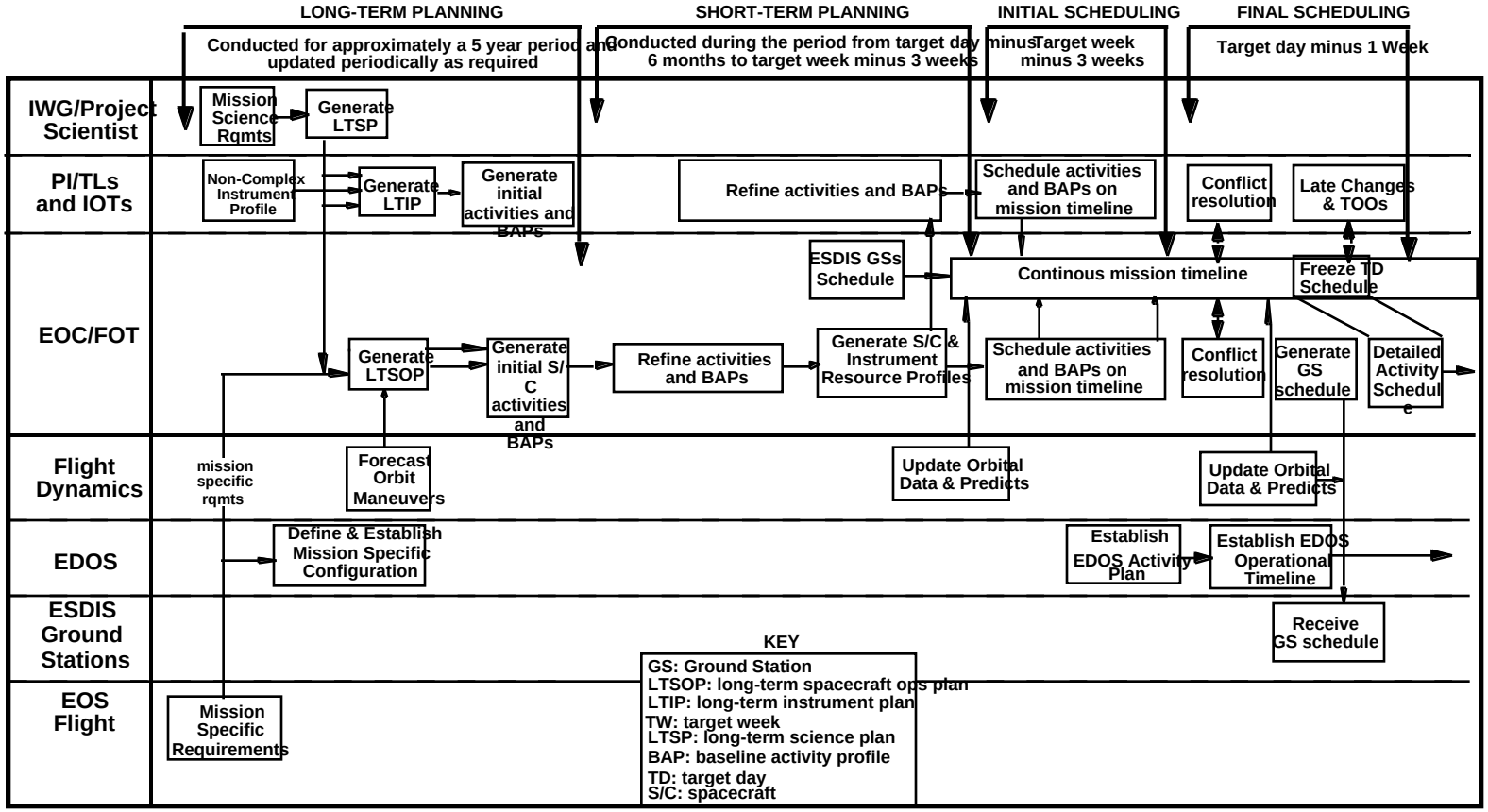
ESDIS

# Chem-1 Planning and Scheduling


- Produces a mission schedule that integrates the instrument and spacecraft subsystems activities
  - Long-term planning
    - Five-year mission planning period, periodically updated
    - Instrument activities defined and initial baseline activity profiles (BAPs) generated
  - Short-term planning
    - Six-month planning period
    - Culminates in updated BAPs and generation of initial S/C and instrument resource profiles; initiates scheduling process 3 weeks before target week
  - Scheduling
    - Initial scheduling begins 3 weeks before target week to refine resource requirements and resolve conflicts
    - Final scheduling begins 1 week before target day
    - Culminates in target day detailed activity schedule

ESDIS

# Chem-1 Planning and Scheduling Scenario



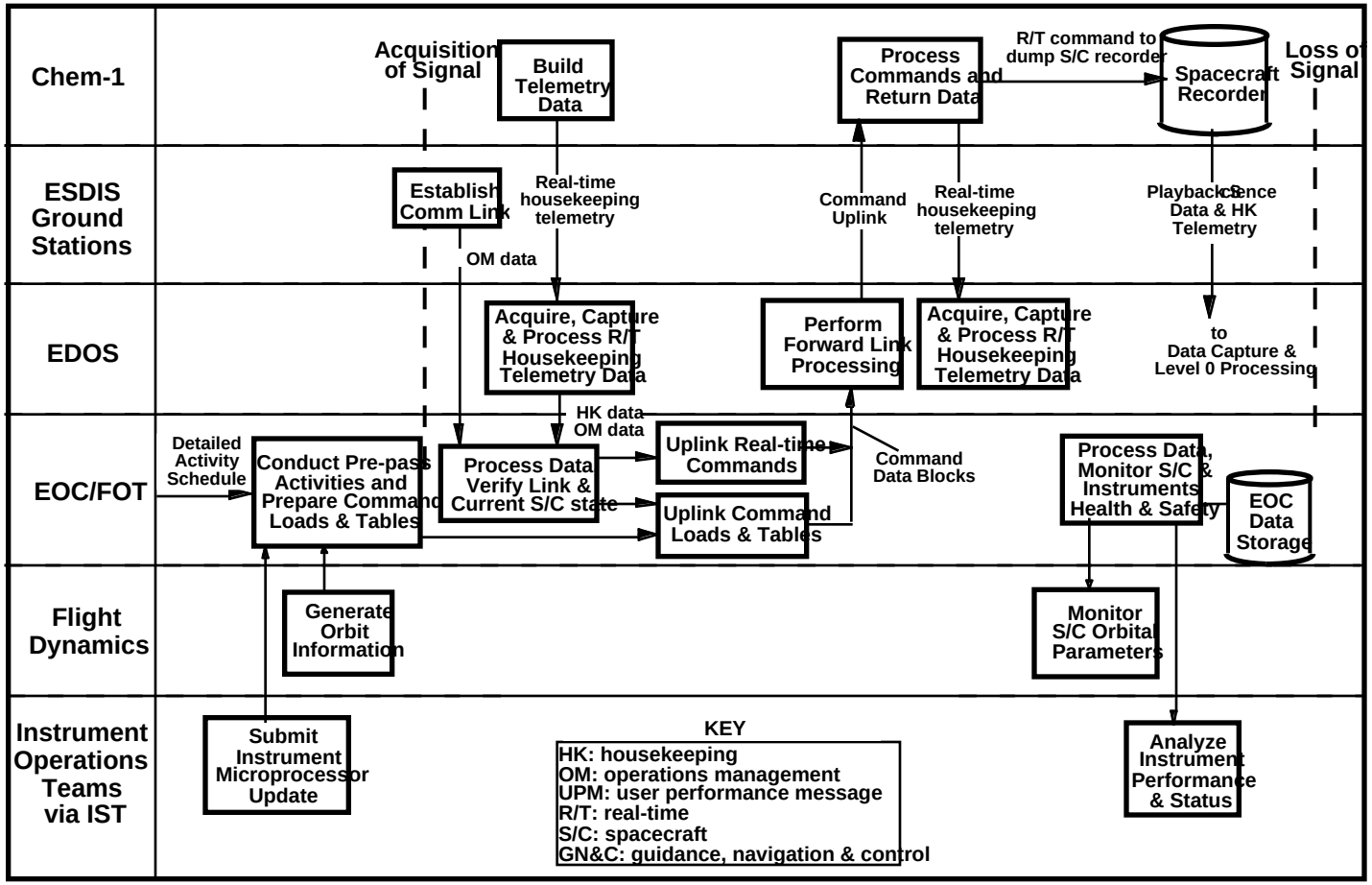
ESDIS

# Chem-1 Command Management and Spacecraft Monitoring


- Commands the spacecraft and instruments, monitors spacecraft and instrument performance, and controls the spacecraft orbit
  - Command management
    - Performs command and control of EOS spacecraft
  - Spacecraft monitoring
    - Performs real-time monitoring of spacecraft telemetry to verify health and safety of the spacecraft subsystems and instruments
    - Maintains onboard clock accuracy
  - Orbit determination and maintenance
    - Performed using TDRS Ranging
    - Prepares orbit adjust maneuver plans

ESDIS

# Chem-1Command Management and Spacecraft Monitoring Scenario



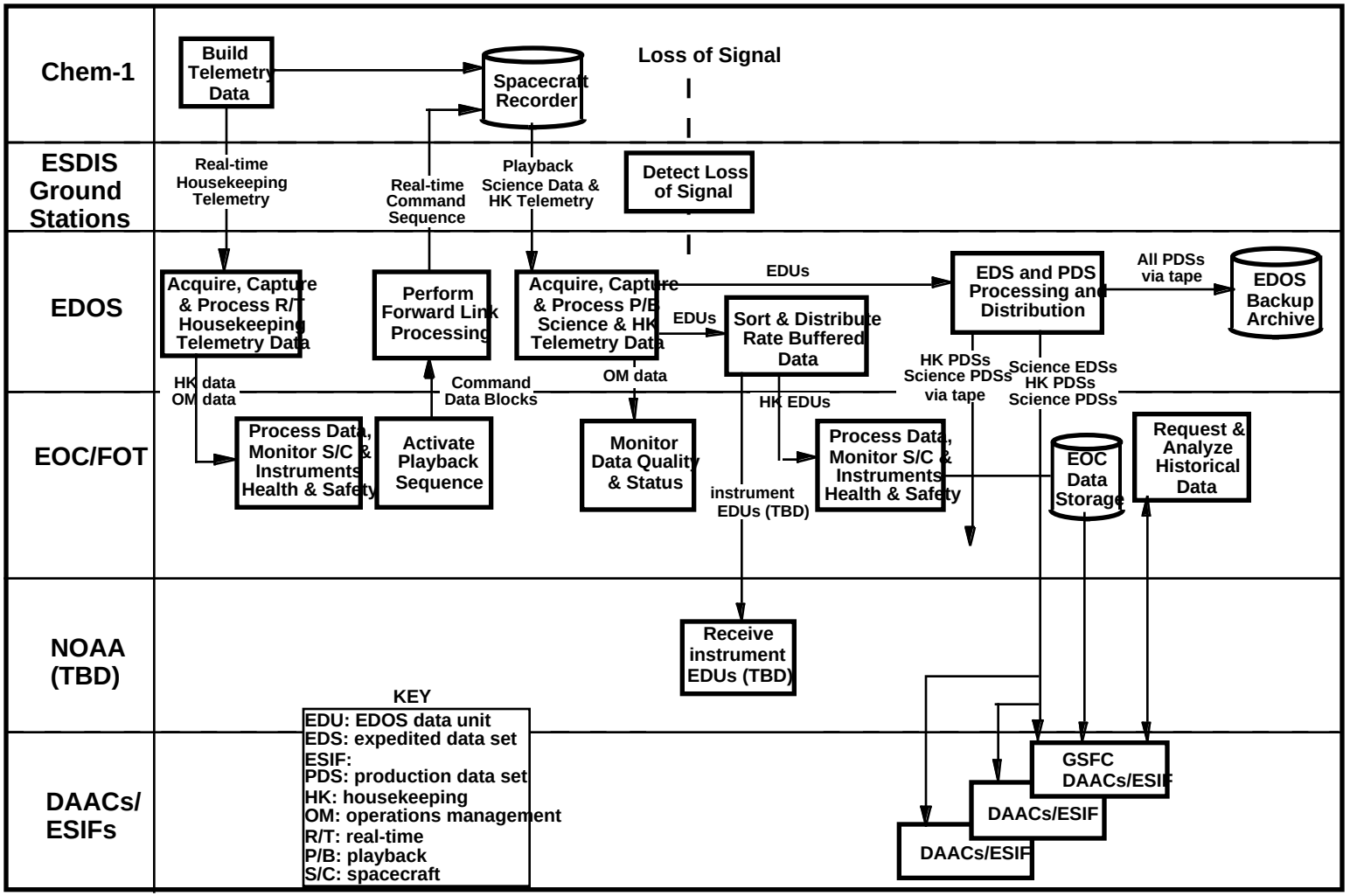
ESDIS

# Chem-1 Data Capture and Level 0 Processing


- Receives, captures, and processes all spacecraft data to Level 0, distributes Level 0 data, and stores all Level 0 data in a backup archive
  - Data capture
    - Captures and records EOS spacecraft data from the EOSDIS Ground Station return link
    - Data are rate buffered to the EDOS LZP at GSFC
    - Processes and delivers real-time housekeeping data in real time and delivers as EOS Data and Operations System (EDOS) data units (EDUs)
  - Level 0 processing
    - All data are Level 0 processed and delivered as production data sets (PDSs)
    - Expedited data are processed first and delivered as EDOS data sets (EDSs)
    - All Level 0 PDSs are recorded on physical media and sent to the EDOS backup archive

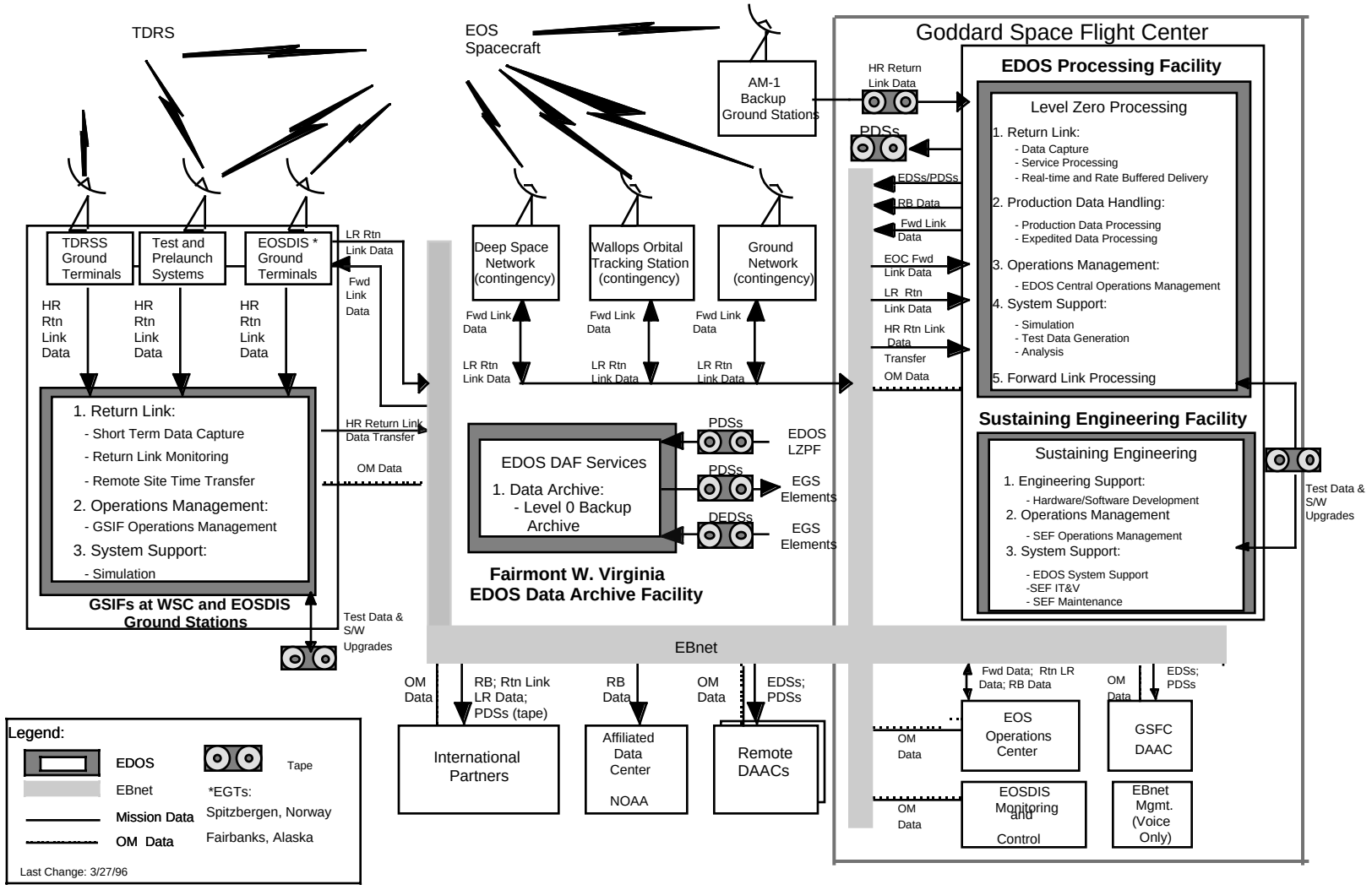
ESDIS

# Chem-1 Data Capture and Level 0 Processing Scenario



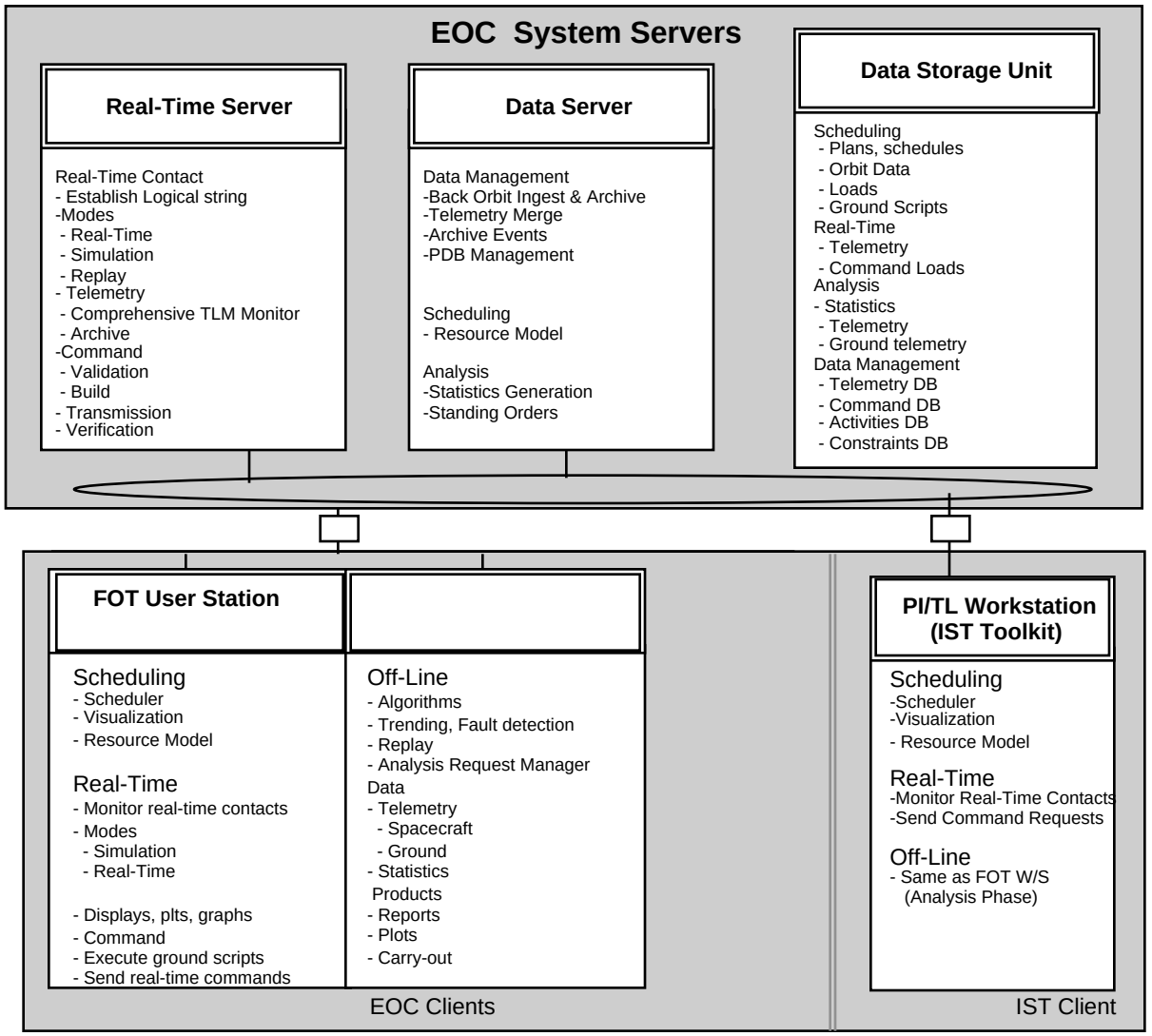
ESDIS

# EDOS Architecture



ESDIS

# FOS Architecture



ESDIS

# Interfaces - S/C and EGS


- X-band Radio Frequency (RF) Interface Control Document (ICD) for AM-1
- Interface Requirements Document (IRD) between EOSDIS and EOS AM-1 for Flight Operations
- ICD between EOS Core System (ECS) and Spacecraft Development and Verification Facility (SDVF)
- ICD between ECS and AM-1 Spacecraft Checkout Station (SCS)
- ICD between ECS and AM-1 Spacecraft Analysis System (SAS)
- ICD between ECS and Spacecraft Simulator (SSIM) (AM-1)
- Data Format Control Document for EOS AM-1 Project Data Base
- AM-1 Data Format Control Book
- EBnet IRD
- ICD between EBnet and SCS
- ICD between EBnet and Flight Software Testbed (FSTB)
- ICD between EBnet and SSIM
- ICD between EBnet and SAS

ESDIS

# Interfaces - FOS Related


- Interface Requirements Document (IRD) between EOSDIS and EOS AM-1 for Flight Operations
- ICD between ECS and Spacecraft Development and Verification Facility (SDVF)
- ICD between ECS and AM-1 Spacecraft Checkout Station (SCS)
- ICD between ECS and AM-1 Spacecraft Analysis System (SAS)
- ICD between ECS and Spacecraft Simulator (SSIM) (AM-1)
- Data Format Control Document for EOS AM-1 Project Data Base
- AM-1 Data Format Control Book
- EBnet IRD
- ICD between EBnet and EOC
- IRD between EOS Data and Operations System (EDOS) and EOSDIS Ground System (EGS)
- EDOS Data Format Requirements Document
- ICD between EDOS and EGS
- ICD between Flight Dynamics Facility and ECS

ESDIS

# Interfaces - EDOS Related


- IRD between EDOS and EOSDIS Ground System (EGS)
- IRD between EDOS and EBnet
- IRD between EDOS and EOSDIS Test System (ETS)
- IRD between EDOS and EOSDIS Ground Terminals (EGT)
- EDOS Data Format Requirements Document (DFRD)
- ICD between EDOS and EGS
- ICD between EDOS and EBnet
- ICD between EDOS and ETS
- ICD between EDOS and NOAA
- ICD between EDOS and EOSDIS Ground Terminals

***All documents available from EOSDIS Library,***

***Building 32, Room E148.  Contact Daphne Rodriguez, (301) 614-5118.***

ESDIS

# Minimizing Life Cycle Costs


- **Development**
  - **FOS utilizing Object Oriented methodology, thus providing high reuse through use class libraries**
  - **EDOS development contractor pursuing commercialization of EDOS technology**

- **Operations**
  - **FOS goal to increase use of expert systems to reduce FOT and perform “lights out” operations on off shifts**
  - **Use of expert systems for solid state recorder management and as expert advisor to Flight Operations Team (FOT).**
  - **EDOS goal of centralized facility management will allow for unattended GSIF operations**
  - **Planned tighter coupling of EDOS and FOS will allow for seamless operations of both EDOS and FOS through a single operations team**


# Science Systems

**Dan DeVito**

**Manager, Systems Engineering**

**ESDIS Project, NASA / GSFC**

ESDIS

# EGS Operations Scenarios


- Mission operations
  - Planning and scheduling
  - Command management and spacecraft monitoring
  - Data capture and Level 0 processing
- Science data operations
  - Data ingest, archiving, and archive maintenance
  - Data processing, ordering, quality assessment, and distribution

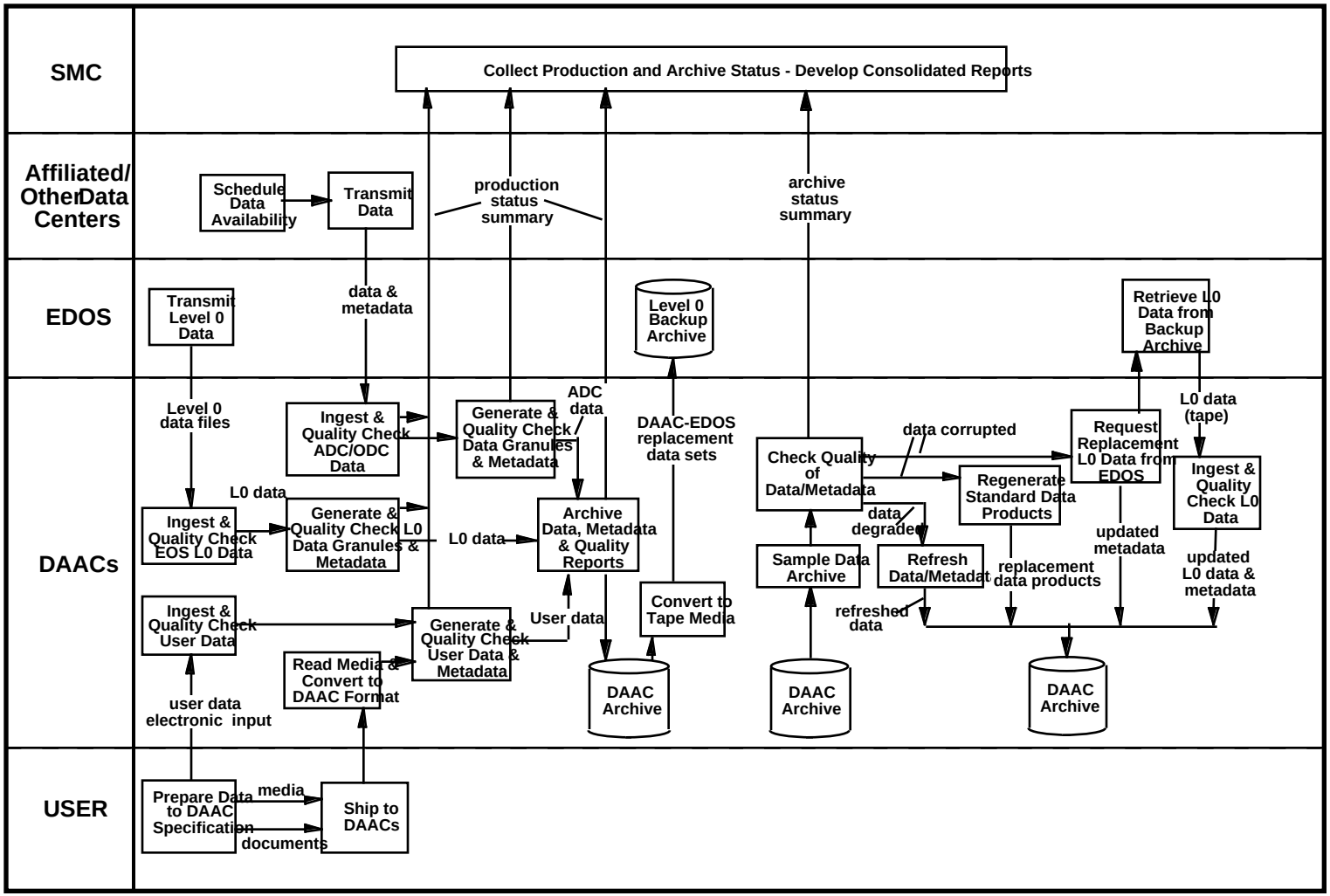
ESDIS

# Data Ingest, Archiving, and Archive Maintenance


- Data are ingested from selected sources and placed in the DAAC archive
  - EOS Level 0 data from EDOS
  - Non-EOS data from Affiliated Data Centers (ADCs)/Other Data Centers (ODCs)
  - User data
- Archive maintenance serves to monitor and maintain the integrity of the data in the archive
  - A subset of the archived data is routinely checked for data degradation or corruption
  - Degraded or corrupted data are refreshed or replaced as required

ESDIS

# Data Ingest, Archiving, and Archive Maintenance Scenario



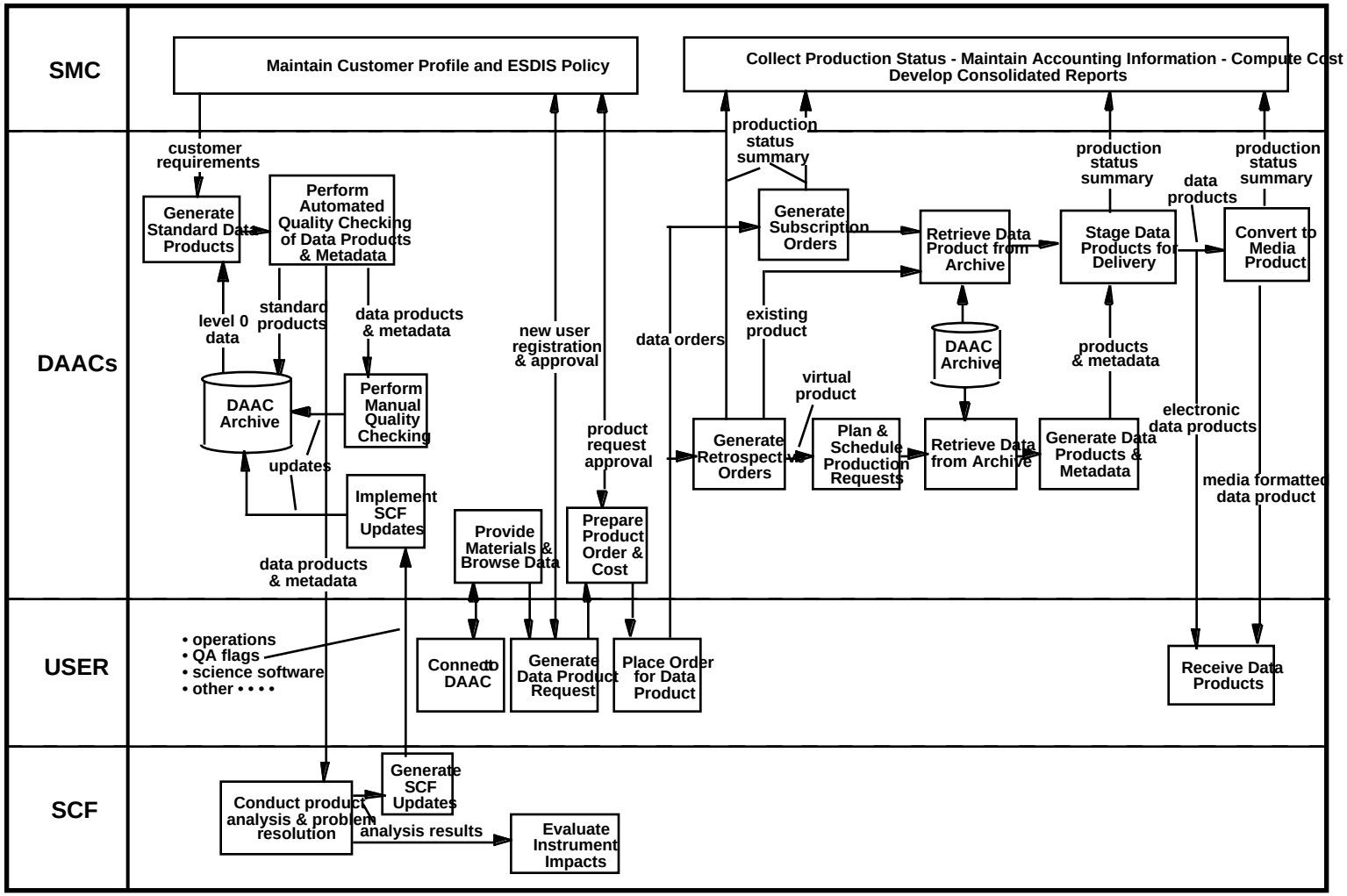
ESDIS

# Data Processing, Ordering, Quality Assessment, and Distribution


- Data processing generates standard data products from all EOS Level 0 data and places the standard products in the DAAC archive
- Data ordering includes subscription orders and retrospective orders
  - Users may subscribe to receive specified standard products (or notification of the products availability) whenever the products are produced and available
  - Users may request products retrospectively from a list of existing and “virtual” products
- Quality assessment includes automated and manual quality checking, and science data quality assurance (QA) performed at the SCFs
- Data distribution stages and delivers products to users electronically and as media

ESDIS

# Data Processing, Ordering, Quality Assessment, and Distribution Scenario



ESDIS

# Interfaces- Science System Related


- IRD between ECS and Science Computing Facilities (SCFs)
- IRD between ECS and NOAA Affiliated Data Center (ADC)
- ICD between ECS and SCFs
- ICD between ECS and NOAA ADC
- ICD between ECS and GSFC Distributed Active Archive Center (DAAC)
- IRD between EDOS and EGS
- ICD between EDOS and EGS
- Release B Science Data Processing Segment Database Design and Database Design Schema Specification
- White Papers
  - HDF-EOS Swath Concept
  - HDF-EOS Grid Concept
  - HDF-EOS Point Concept
  - Preliminary EOSDIS Browse Package Description
  - HDF-EOS Primer for Version 1 EOSDIS
  - HDF-EOS User's Guide for the ECS Project
  - The Metadata Population Process for the ECS System and Subsystems
  - An ECS Data Provider's Guide to Metadata